

Exchange risk assessment, case of application to an importing company

Evaluación de riesgo de cambio, caso de aplicación en empresa importadora

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Abstract

This applied investigation had as objective to establish a short-term financial cover to control the impact of loss on profits due to the exchange rate risk on the COP/USD ratio, in a company dedicated to the import and marketing of tires in Colombia. For the above, it was necessary to carry out a quantitative analysis between the options and forward coverage, requiring the use of the Black Scholes technique for the calculation of the premium; Likewise, it was necessary to simulate through different forecasting methods

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to choose the lowest RMSE error, presented as a result the time series which was used to project the future behavior of the dollar through the Risk Simulator software. Finally, it was evident that a great part of the background for the present investigation is of a qualitative type, some of the existing quantitative origin are not focused on case studies; otherwise, the results obtained allowed to demonstrate that the best coverage is the purchase of the Call in The Money option because of the financial benefit generated.

Keywords: *Black Scholes, Forward, Options, RMSE, Risk Simulator*

Resumen

La presente investigación aplicada, tuvo como objetivo establecer una cobertura financiera de corto plazo que permitiera controlar el impacto de pérdida en las utilidades por el riesgo cambiario en la relación COP/USD, en una empresa dedicada a la importación y comercialización de llantas en Colombia. Para lo anterior, fue necesario realizar un análisis cuantitativo entre las coberturas opciones y forward, requiriendo emplear la técnica de Black Scholes para el cálculo de la prima; así mismo, fue necesario simular a través de diferentes métodos de pronóstico para elegir el de menor error RMSE, presentado como resultado la serie de tiempo el cual fue utilizado para proyectar el comportamiento futuro del dólar por medio del software Risk Simulator. Finalmente, exaltando las principales conclusiones se evidencio que gran parte de los antecedentes a fin con la presente investigación son de tipo cualitativo, algunos existentes de origen cuantitativo no se enfocan a casos de estudio; de otra forma los resultados obtenidos permitieron evidenciar que la mejor cobertura es la compra Call opción In The Money por el beneficio financiero que se generó.

Palabras clave: *Black Scholes, Forward, Opciones, RMSE, Risk Simulator*

Introduction

In Colombia, the evolution of banking penetration has been mainly linked to microcredit as a financing system for small businesses; however, little recognition was given to other financial services such as payments, fund transfers, savings and insurance (Tafur, 2009), and to the financial knowledge and skills needed to identify issues such as the relevance of savings, detect the product according to needs and plan the costs involved, and the operation and advantages of having insurance to address the risks that can impact finances (Dinero, 2019); as well as the appropriation of knowledge on investment issues in the capital market, risk management and profitability for the optimization of resources. It is necessary to exalt the importance of keeping in mind that:

There are very efficient and diligent companies in terms of developing their own business activity that, however, do not have comparative advantages that allow them to manage the risks associated with the volatility of variables exogenous to their reason for being, in a more efficient way than other market agents (Arango and Arroyave, 2011).

Volatility “measures the increase or decrease in the price of an asset over a given period of time” (Lizarzaburu Bolaños, Burneo, Galindo, & Berggrun, 2015). Otherwise, from a financial management the company in the management of exchange rate risks can be considerably affected in the cash flows and its potential in the operational and financial activity of the company (Vivel, 2010); in another condition an optimistic and opportunistic moment of high solvency, before the need to compete promotes the execution of projects that allow to overcome the local environment to belong to international environments with new business opportunities and strategic challenges in each area.

Exchange risk is the effect on local currency prices of the application of the exchange rate in foreign currency purchase and sale operations (Díaz y Redondo, 2019), which may be intensified for an exporting or importing business in a context of a flexible exchange rate regime, within which the value of the foreign currency in local currency fluctuates freely (Lizarzaburu and Berggrun, 2013), generating a devaluation or revaluation, impacting on emerging economies by the influx or outflow of external capital, which in turn is determined by the policies of their central banks; This is why the main Latin American economies seek at all costs to meet inflation targets, using the exchange rate as the nominal anchor (Rosas Rojas, 2016), in order to avoid contracting commercial activity and generating economic shocks; which on the contrary in industrialized countries can emerge from an exchange rate crisis without any damage (Ramírez, Romero and Lozano, 2007).

Otherwise, the exchange rate risk is considered “easily covered with the mechanisms available in the financial system but in the long term, which is the horizon in which direct investment operates” (Lizarzaburu and Berggrun, 2013), such as currency hedging instruments that reduce the volatility of returns through an efficient portfolio that benefits from market liquidity (Clavellina, 2018), limiting the risk by agreeing on a fixed price for the currency so that the fluctuations generated by the devaluation of the peso in the future do not affect money flows; However, it should be borne in mind that when incurring in futures contracts and other types of transactions even if a cost is paid for them, security is never complete (Chapoy, 2004).

The management of the exchange risk in the country during the last years has been in a constant evolution, not only because it is the most liquid market, but also due to the need to reduce the funding costs obtained when accessing the international market (Cardozo, Rassa y Rojas, 2014). Due to the constant relation between the peso and the dollar, the demand for coverage in

this country comes mainly from the importing companies, which can access to coverage and investment strategies offered by the financial system, such as forwards, options, cross-currency swaps and the currency tunnel; However, participants in the derivatives market implement forwards in their foreign trade operations, followed by options (Cardozo, Rassa and Rojas, 2014), as a more common way of protecting future cash flows against exchange rate risk (Salazar Garza, 2012), which will be the subject of this research, since hedging instruments such as Cross-Currency Swaps cover long-term exchange rate exposure and generally, at the end there is an exchange of interest to offset existing interest differentials between different currencies, which is costly for this type of market participant (García, Pérez and Tovar, 2016). Also, the currency tunnel is not widely used by importers in Colombia, since the price or position taken is exposed to the volatility curve in Colombia and would only serve to obtain profits in the face of expectations of an appreciation of the Colombian peso (Cardozo, Rassa and Rojas, 2014).

Some authors, to evaluate the exchange rate risk, from the perspective of an effect on the performance and permanence of the companies, the implementation or adoption of coverage to mitigate this type of risk, carry out research such as that carried out by Romero et al. (2019) applied to some SMEs in the municipality of Sincelejo with the objective of “establishing the current state of exchange rate risk management in several SMEs in the municipality of Sincelejo in Colombia. In general, there was a lack of knowledge among the SME entrepreneurs about the alternatives for managing foreign exchange risk”.

Likewise, multiple studies carried out by Vivel et al. (2012) have investigated the impact of the exchange rate risk in the locality of Spain showing that "Spanish companies maintain, in majority, an attitude of covering their exchange rate exposure, fundamentally, through the use of financial techniques such as derivatives and foreign currency debt"; Similarly, a qualitative

research was led in Mexicali, Baja California to "determine how currency risk affects the performance of commercial companies dedicated to the purchase and sale of women's clothing, derived mainly from the rise in the price of the dollar" (Carrillo et al, 2017), through the application of a questionnaire which was submitted to statistical tests through Cronbach's alpha to determine its reliability, concluding that businessmen faced with changes in the price of the dollar, increase their prices, without analyzing the market, reducing purchases and supplying themselves with products from the national market without making coverage to protect themselves against this type of economic event, a situation that affects their liquidity and puts their permanence at risk.

On the other hand, investigations such as "the strategy of exchange coverage by means of futures for a company that imports vehicle parts and accessories in Colombia", allowed contributing with significant experiences that exalt the importance of the knowledge and application of coverage contracts in companies dedicated to the negotiation with foreign currency, since in the results they showed that it is possible to diminish the risk associated to the exchange volatility when implementing futures contracts, assuring an expected profitability by the company (Ospina, Jiménez and Rojas, 2017).

The study "Hedges with futures and options to reduce the exchange risk in exporting companies in Colombia", could conclude that the hedge with futures granted benefits in the unit price with which the dollars are obtained by an upward trend; on the contrary, an option contract showed loss in the exchange value that the scenario without hedge (Jiménez, Acevedo and Rojas 2017).

Otherwise, it is worth highlighting, in addition to the investigative background, the importance of the theories that influence the investigation, such as exchange rate risk, which is known as the implication of the loss or gain in the exposure

derived from collections or payments in currency. foreign, is classified according to the type of exposure, which can be transactional, conversion, operational or economic and depends on the changes in value that may occur at the time of the transaction, conversion changes for the value of money over time, the implication of the market value of a company due to the change in the price of the currency, exposure in negotiations with international agents where they assume the ability to face exchange risk (Ogáyar Sanchiz, 2015).

In Colombia, these hedges can be carried out in two different markets, such as the over-the-counter or also known as OTC, and the stock market, managed by the Colombian Stock Exchange. These markets are different because in the first one there is a direct interaction between the two parties, where certain terms and conditions are established that can be agreed looking for a common interest in each position; these interests refer to the rates, the established time, the amount to negotiate, among others. In the stock market these terms are already pre-established, and there are respective regulatory entities in charge of providing guarantees to the system so that the procedure is carried out correctly, such as the clearinghouse, the central securities deposit and the Colombian Stock Exchange.

The most used instruments correspond to futures, belonging to a standardized market, forwards, options and swap to an over-the-counter market (OTC), which are described as follows:

Table 1. Characterization of OTC hedge contracts

INSTRUMENT	CHARACTERISTICS	VOLUME OF TRANSACTION - IMPORTS
FORWARD PESO-DOLLAR	<p>Lower cost, since they do not require the exchange of flows at the beginning of the contract.</p> <p>They are carried out in the short term, less than 30 days</p> <p>High Liquidity.</p> <p>No cash flow is compromised</p> <p>They imply a lower credit risk since they are usually agreed on short terms and can be compensated through a CRCC</p> <p>They have a clearer procedure for accounting</p> <p>They are less expensive in tax terms.</p>	High
OPTIONS PESO-DOLLAR	<p>The bookkeeping of these types of instruments is not clear, and their tax treatment makes them more expensive</p> <p>Generally its use is medium term, average of the operations is 90 days.</p> <p>Call's purchases are par excellence the busiest operations.</p> <p>They require the payment of a premium, therefore, they require the exchange of flows at the beginning of the contract.</p>	Medium
CROSS-CURRENCY EXCHANGES	<p>They agree on the exchange of interest flows in different currencies.</p> <p>They cannot be settled for differences, as the payment flows in the two currencies are different.</p> <p>Long-term use.</p> <p>Companies with high levels of foreign currency debt</p> <p>Higher Cost</p> <p>The largest participants in this market are the foreign agents,</p>	Low
CURRENCY TUNNEL	<p>It is mostly used by exporters.</p> <p>Establishes exchange rate fluctuation limits.</p> <p>It allows you to benefit from favorable exchange rate movements.</p> <p>It limits losses in exchange for unfavorable movements.</p>	Very Low

Source: Elaborated from:

* Cardozo Alvarado, N., Rassa Robayo, J. S., & Rojas Moreno, J. S. (2014). Characterization of the Exchange Derivatives Market in Colombia Drafts of economics. Obtained from Caracterización del mercado de derivados cambiarios en Colombia: https://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_860.pdf

*García Núñez, J., Pérez Fructuoso, M. J., & Tovar Jiménez, J. (2016). Corporate finance II. derivatives as a hedging instrument. Udimia.

Option contracts can be made on shares, interest rates, stock indicators and currencies. The latter allows reducing the uncertainty derived from the unfavorable variation in the exchange rate that can occur in the future, assuming a cost called premium (Díez de Castro, 2008).

The options are divided into purchase characterized by the name Call and sale by put, of which the premium is recognized for the first by C and the second by P, depending on the period, can be exercised in American or European type, the first option inferring that it can be executed before or during the expiration, on the contrary, the European only in the date of expiration of

the contract. The value gained or lost corresponds to the market price on the date minus the strike or exercise price minus the premium (Montserrat Casanovas, 2014).

In the Call option, future prices are expected to increase, so the buyer is prepared to pay a premium, which if the asset exceeds the strike price before maturity, will buy the asset at the strike price. The higher the price of the asset, the greater the profit for the buyer of the Call. Conversely, in an expectation that prices will fall, the scenario is to buy puts, since "the lower the market price with respect to the strike price, the greater the profit for the buyer of the put" (Baca Urbina & Marcelino Aranda, 2016).

The profit that would be obtained from an option if it is exercised is called the intrinsic value which is evaluated in the Call as the market value minus the exercise value ($S - E$); for the Put option, the exercise value minus the market ($E - S$); whose result can be a positive or negative differential value, which determines whether the contract is exercised, or the premium is paid. This decision is evaluated based on the criteria In The Money (ITM), AT The Money (ATM), Out The Money (OTM) for each option as shown below:

Table 2. *Assessment of the intrinsic value of Call and Put*

Description option	CALL	PUT
ITM	$S > E$ Exercise the option	$S < E$ Exercise the option and pay the premiums
ATM	$S = E$ Either exercise the option or pay the premiums	$S = E$ Either exercise the option or pay the premiums
OTM	$S < E$ It doesn't exercise the option and pay the premiums	$S > E$ It doesn't exercise the option and pay the premiums

Source: Prepared by the authors from Rona Azekely, J. (2007). A practical guide to derivative financial instruments. Editorial Fund of the Pontificia Universidad Católica del Perú

The calculation of the option premium is done through the Black Scholes methodology, which "considers that the stock exchange follows a random trajectory, like the Brownian movement of particles suspended in the fluid" (Serrano García,

2014), which defines that “in their trajectories at no point do they have a derivative; that is, it is formed only by peaks and that is why we cannot talk about the speed of a possible Brownian movement trajectory” (Tresierra Tanaka & Carrasco Montero, 2016). This formulation considering its fulfillment to the expiration date, is represented by the following equation as it is sustained by the author Fernández (1997):

$$C = S N(x) - K r^{-t} N(x - \sigma\sqrt{t}) \quad [1]$$

Where:

$$x = \frac{\ln(s/Kr^t)}{\sigma\sqrt{t}} + \sigma\sqrt{t}/2 \quad [2]$$

C= Price of call option (T=0)

T= Period of validity of the call option

r= 1+ risk-free interest rate between T=0 and t.

σ = Annual asset volatility by one

K= Exercise price of the call option

S= Price of the asset in t=0

N(x)= Value of the cumulative probability function of a standard normal distribution

Otherwise, you must consider the option calculation; in which you must have the following variables: Forecast at the end of the period - market value, strike price, premium paid and profit/loss. The Forecast at the end of the period -Market value: Numerical values in which the representative rate of the market can be found at the end of the period, established in a speculative way by the work team.

Price of the year or strike: Price agreed by the company before the financial entity; this will be fixed.

Premium paid: Price established by the financial entity; this will be fixed.

Profit/Loss: Numerical value that expresses whether the operation yields a positive or negative economic result for the company.

A forward constitutes a private agreement between a seller and a buyer, where the seller agrees to deliver a specific real (products such as wheat, corn, gold, etc.) or financial (currencies, rates and interest, etc.) asset (called the underlying) to the buyer at a specified future date, and the buyer agrees to pay the seller an agreed price (the contract price) upon delivery (Pérez Barbeito, 2014).

Forward contracts are the oldest and most widely used foreign exchange risk management instrument in international trade, finance and investment. They can also be used as speculative instruments. Forwards belong to the OTC (over-the-counter) market, and the amount of a contract usually exceeds one million dollars. The contracting parties can be a bank and its client, or two banks (Kozikowski Zbigniew, 2013).

Historically, derivative markets were born as over-the-counter (OTC) markets, in that contracts are negotiated bilaterally, and the risk of default is assumed by both parties (Ramírez Celada, 2006).

According to Baca et al., (2016), this OTC contract is evaluated by applying the basic economic engineering formula to obtain the future price of the asset at maturity as presented in the following formula:

$$F = P (1 + i)^n \quad [3]$$

Where:

P = Present value of the COP/USD ratio

n = Number of working days of the period to be carried out based on the year.

i = Implicit devaluation rate of the COP-USD Forward contracts, given by the bank of the republic.

The quality of forecasts generated with a quantitative approach deteriorates as the variability of the data increases, therefore, it is necessary to consider the greater number of historical data, to improve the adjustment of the forecasts (Krajewski & Ritzman, 2000). Therefore, in the estimation processes of the forecast model of variables with high volatility as is presented in the subjacent

assets of the stock market or the macroeconomic variables, it is required to determine the formation of prices, expressed in the following formulation (Serrano García, 2014):

$$Pt = P_{t-1} * \exp(r_t) \quad [4]$$

Where:

P_{t-1} = At previous value of the asset

$\exp(r_t)$ = Estimated current value yield

Being r_t :

$$r_t = \ln\left(\frac{Pt}{P_{t-1}}\right) \quad [5]$$

\ln = Neperian logarithm of current price over previous value of asset

Also, errors in the forecasts are necessary to estimate them, since this allows to identify the model that has less bias with the original values when compared with the estimated ones, these can be bias or random errors (Krajewski & Ritzman, 2000). Among the random errors, it is possible to identify the RMSE, which in itself is an inferential statistic and econometric concept, the difference between the real and the predicted values (Barreto & Howland, 2006), using the root equation of the mean square error (Kurková et al., 2018), as expressed below:

$$RMSE = \sqrt{\frac{(Y_t - \hat{Y}_t)^2}{n}} \quad [6]$$

Among the forecasting theory, there are different simulation models that allow determining the future values of the assets, among the most used is the Monte Carlo Simulation, a methodology initiated by Boyle in 1997, which allows the simulation of stochastic processes whose accuracy in the results depends on the number of scenarios that are projected (Prósper Lamothe & Somalo Pérez, 2006). The results of the process can be Gaussian taking negative values which for some forecasts is an undesirable result (Martínez & Villalón, 2013). Likewise, the Time Series allows to evaluate the data from the decomposition in four components like the tendency, a gradual movement of the data in the time that can be ascendent or descendent; the

seasonality, corresponding to the pattern of repetition of data of a period; the cycles, infer in the repetition of the data but after several years and random variation, data generated by chance or by unusual or not estimated incidents (Heizer & Render, 2004).

The Auto ARIMA methodology has the functionality to automate several permutations of the model specifications to project the one that fits best, through the dependent variable and multiple independent ones, without limiting the number of data to be forecasted if only the time variable Y is used; if X variables are considered the limitation is presented by the number of data periods of exogenous variables minus the data periods of the time series variable (Mun, 2016).

Stochastic Processes that consist of a mathematical equation that generates a series of results are not deterministic over time, allowing a simulation that originates several trajectories for prices, allowing a statistical sampling of the potential trajectories of the simulation, where the Brownian motion is a random walk (Mun, 2016), observed by botanist Robert Brown, who noticed that pollen grains in watery solution have an irregular motion trajectory; which gave rise to Bachelier's proposal that stock prices behave in a Brownian way, which means unpredictable due to the efficient market assumption that the next price depends only on the price at that time and not on its history of variation (Ramos et al., 2019).

Materials and methods

The objective of this applied quantitative research is to demonstrate the benefits that could be contracted to implement other non-standardized hedges in 2018, other non-standardized hedges such as options and/or forward contracts to reduce the exchange risk in the company under study dedicated to the import and marketing of tires, which to date was negotiating futures contracts.

The development of this research was determined by four phases, the first one was a test and modeling exercise concerning finding the method with less error value to forecast the TMR with the help of the Risk Simulator tool, later, the exchange rate volatility was evaluated and the TMR was projected 5 days, In the third phase, the premium calculation methodology was applied using the Black Scholes method, followed by the evaluation of the Call option coverage and finally the forward coverage was applied to analyze the results and to demonstrate the best coverage technique to be implemented in the company.

Results

The importing company of tires located, by October 3, 2018 had pending the payment of an invoice to its suppliers abroad in the amount of \$1,000,000 USD. On September 26, 2018, it decided to make an exchange coverage to fix the price of the dollar, to insure in pesos (COP) the cost of the invoice in the future date. The coverage evaluated to contemplate the one that generated the greatest benefit was between the Call option and the forward.

Buying a Call Option: Based on the value of the COP/USD of the underlying asset on September 26, 2018, which was \$ 3,001.88 and an estimated strike price of \$ 2,948.34. The value of the exercise of the option or the Strike, was considered from the proximity and level of confidence in the test evaluation with lower RMSE of the behavior of the TRM that was the Monte Carlo Simulation; therefore the K Sigma methodology was contemplated emphasized in the Lower Effectiveness Limit (LEI) that refers to the mean minus one deviation (Gómez and Tocino, 2004); in order to have the reference value to contract the option taking into account that it refers to the same methodology assigned to determine the expected results of the lower limit, average and upper limit of the exchange rate on October 3, 2018.

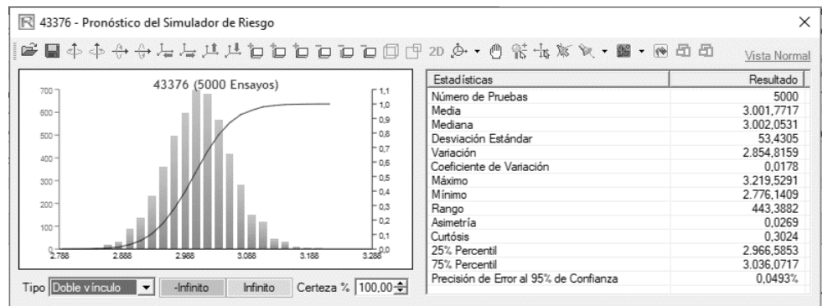
The strike was \$2,948.34 pesos, considering an average of \$3,001,7717 pesos and a deviation of \$53,4305 pesos. Initially a test sample was made with data from January 2, 2018 to September 20, 2018 in order to evaluate with the real data from September 20 to 26 of the year the RMSE error in the Monte Carlo Simulation, Time Series, Auto ARIMA forecast models, Stochastic Forecast with Exponential Brownian Movement, which would allow choosing the least error to estimate the TRM of 5 working days later which as short term coverage would be adjusted with a high probability in order to carry out the evaluation of the contracts for October 3, 2018.

When performing the Monte Carlo Simulation test with simple distribution fitting, it was presented that the historical data of the Nigerian logarithms of TRM were adjusted for a logistic distribution commonly used to describe growth, whose P-value was 91.02%,

To evaluate the simulation of the historical period from September 20, 2018 to October 26, 2018, then the RS Forecast Statistic (simulated TRM value; "average") was calculated, the result of the RMSE error for this method was \$9.24 cents, the time series with the double exponential smoothing \$9.39 cents, Auto ARIMA \$15.81 cents, Stochastic Forecasts with the exponential Brownian motion \$9.37 cents. The above concluded that the forecast to use was stochastic.

Finally, the estimated value for October 3, 2018 was \$ 3,001.77 pesos through the logistic distribution of historical data of the TRM in 2018 gave a P-value of 89.97% for the estimation of the Monte Carlo Simulation; the minimum expected value of the TRM for this day was \$2,981.83 pesos and maximum of \$ 3,021.72 pesos with a confidence level of 95%.

Figure 1. Mock test MRT from day 26th of September 2018



P.S: Prepared from the data of the Colombian Government Open Data Representative Exchange Rate and Risk Simulator.

Source: Government of Colombia. (2020). Open data. Obtained from Representative Exchange Rate or TRM (for Spanish): <https://www.datos.gov.co/Econom-a-y-Finanzas/Tasa-de-Cambio-Representativa-del-Mercado-Historic/mcec-87by>

Thus, the first coverage simulation was carried out, with the purchase of a Call option starting on October 26, 2018 for 5 days (Business Days) corresponding to October 3, which was agreed at a price of \$ 2,948.34 pesos with the corresponding financial entity. In accordance with these conditions, the entity establishes as business parameters a risk-free rate of 2.25% EA and a premium of \$ 53.54 COP per USD.

For the respective premium calculations, it was necessary to apply the Black-Scholes model, in which two variables of high impact on the results were highlighted: the risk-free rate and the volatility. The risk-free rate worked was 0.0062% (2.25%), corresponding to the daily percentage of the Federal Found Rate of September 26 (Bank rate, 2016) and the volatility was specified with the historical information of the TRM of the year elapsed or also called Year to date, since the exercise was agreed in that same period.

Once the historical information was obtained, we proceeded to calculate the volatility with the Nepalese logarithms of the series and the sample standard deviation of the same, which corresponded to a volatility of 0.724%.

With the above, the Black Scholes model was made, considering the market price variables of September 26, corresponding to \$3,001.88 pesos, the value of the exercise that was previously determined by "2.948,34 pesos, the estimated volatility, the risk-free rate and the time factor of 0.0137, which gave rise to a Call of \$53.54 pesos per dollar.

To classify the options in relation to the strike price of the option and the price of the underlying, an expected forecast was made for October 3, 2018 of \$3,001.77 pesos; a lower limit of \$2,981.83 pesos and an upper limit of \$3,021.72 pesos with a 95% probability.

Table 3. *Assessment of the option in function of the Call*

Price of the exercise (E) \$ 2948,34 COP		
Option Call		
Market Price (S)	Type of option	Interpretation
\$2.981,83	ITM (in the money)	
\$3.001,77	ITM (in the money)	
\$3.021,72	ITM (in the money)	It will produce benefits to the buyer. Market Price (S) > Price of the exercise(E)

Using the forecast series of the underlying, the following results were given:

Table 4. *Practical exercise, buy Call.*

DESCRIPTION PRICE OF THE MARKET	Inferior Limit	Media	Superior Limit
MARKET PRICE	\$2.981,83	\$3.001,77	\$3.021,72
PRICE OF THE EXERCISE OR STRIKE	\$2.948,34	\$2.948,34	\$2.948,34
ASSESSMENT OF CALL	\$33,49	\$53,43	\$73,38
PREMIUMS PAY X DÓLAR	\$53,54	\$53,54	\$53,54
PARTIAL PROFIT OR LOSS	-\$20,05	-\$0,11	\$19,84
EARNINGS FUNCTION	\$-20.050.000	\$-110.000	\$19.840.000

The maximum loss is limited to the value of the premium, which for this year is \$53.54 per dollar, or \$53,540,000, while the gain is unlimited. If the dollar reached the upper limit of \$3,021.72, the net profit would be \$19,840,000.

Forward Contract: According to Baca et al., (2016), this OTC contract is evaluated by applying the basic economic engineering formula to obtain the future price of the asset at maturity as presented in the following formula: $F = P (1 + i)^n$ from where:

$P = \$3.001,88$.- present value of the COP/USD ratio.

$n = 5/365$ - number of working days of period to be carried out based on the year.

$i = 1.26\%$ (Term 3 to 14 days - September 2018) - Implicit devaluation rate of the Forward COP-USD contracts of Banco de la República de Colombia (Colombian Republic Bank).

Therefore, the future value for this exercise would be as follows:

$F = 3.001,88 (1+0,0126)^{0,0137}$

$F = 3.002,39$

To determine the profit or loss generated by the forward contract, the price of the dollar on the day the debt was contracted (initial spot) is taken and multiplied by the amount, this result is subtracted from the price of the dollar on the day the invoice is due (final spot) and the amount, if the result of the subtraction is positive it means that the company is saving money, but if the result of the subtraction is negative it means that the company is incurring a loss.

-Starting spot: \$3,001.88 Value that had a dollar the day the company acquired the debt.

-Final spot: \$3,002.39 Estimated future value.

-Amount: \$1,000,000 Amount owed by the company

Chart 5. Exercise Contract Forward

CONTRACT FORWARD						
AMOUNT USD	INITIAL SPOT	FINAL SPOT	DIFFERENCE	PAYMENT IF THE PRICE IS STABLE	PAYMENT WITH CONTRACT FORWARD	EARNINGS / LOSSES
\$1.000.000	\$3.001.88	\$3.002.39	-\$0.51	\$3.001.880.000	\$3.002.394.940	-\$514.000

The result obtained showed that, if the company paid the bill without contracting any type of coverage, it would have to pay \$514.000 pesos more than it had budgeted to pay on the day it

contracted the debt, this overpayment corresponds to increase of the price at future.

Table 6. Coverage comparison

INITIAL CONDITION						
	AMOUNT USD	MARKET PRICE (PRICE TODAY)	PAYMENT IF THE PRICE WAS STABLE			
	\$1.000.000	\$3.001,88	\$3.001.880.000			
BUY CALL IN THE MONEY						
MARKET DESCRIPTION	MARKET PRICE	STRIKE	DIFFERENCE	PREMIUMS	PARTIAL EARNINGS OR LOSSES	EARNINGS FUNCTION
Lower limit	\$2.981,83	\$2.948,34	\$33,49	\$53,54	-\$20,05	-\$20.050.000,00
Media	\$3.001,77	\$2.948,34	\$53,43	\$53,54	-\$0,11	-\$110.000,00
Upper limit	\$3.021,72	\$2.948,34	\$73,38	\$53,54	\$19,84	\$19.840.000,00
CONTRACT FORWARD						
AMOUNT USD	INITIAL SPOT	FINAL SPOT	DIFFERENCE	PAYMENT IF THE PRICE WAS STABLE	PAYMENT WITH CONTRACT FORWARD	EARNINGS / LOSSES
\$1.000.000	\$3.001,88	\$3.002,39	-\$0,51	\$3.001.880.000	\$3.002.394.940	-\$514.000

When analyzing the results that were presented of the different types of coverage, it was determined that the coverage that generated more benefit for the importing company was the purchase of Call with a Strike of \$2,948.54 pesos, a profit of \$19,840,000 pesos, in a scenario where the price could oscillate by \$19.84 pesos above the market price, in this case the company benefited because the value paid for the premium, was the maximum loss that could have when exercising the option; therefore, any upward movement would be a profit scenario for the company.

In conclusion, if a company needs to generate profit with a hedge, it is necessary to set the strike price based on analysis that determines the smallest error in the expected forecast of the initial spot rate or also called market price. Likewise, the purchase of Call must be contracted, since it is a flexible hedge that allows

you to have profits both when the spot rate rises and maintaining the value of the dollar budgeted strike price, which allows you to maintain the financial stability of the company.

Conclusions

It was evident in the background study that most of the recognition research in indexed journals is of a descriptive and qualitative type, where the evaluation of exchange risk is focused on the application of a diagnostic instrument and in a smaller proportion quantitative studies applied to case studies were found.

The hedge that offers more flexibility and greater possibilities of obtaining benefits both to the rise of the price of the dollar and to the fall, is the hedge that is contracted with options.

Risk Simulator is a complete and efficient tool when projecting the values of the variables that were used to structure the hedges, since the results they give are reliable and allow to have an approximation to the values that are going to be presented in real life, estimating different scenarios in time.

Investors should not negotiate with certain foreign currencies expecting the peso to revalue against that currency, on the contrary, they should contract hedges and seek to obtain benefits in any situation, establishing optimistic, moderate and pessimistic scenarios.

Before implementing a financial hedge, it is important to estimate the trend and possible values of the asset at which the risk is required to be managed due to the effect of uncertainty, since these would allow a more objective analysis to be made in accordance with expected expectations.

Structuring the possible future results of the variables, will not always be security to make the investment, since there are many macroeconomic factors that may influence the values they take and make them have a different volatility than the one believed.

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